FINAL - ER 77 – Electrician Regulations Answer Schedule

Notes: 1. (1 mark) means that the preceding statement/answer earns 1 mark.

2. This schedule sets out the expected answers to the examination questions. The marker can exercise their discretion and decide on the overall accuracy of any answer that is presented in the candidate's own words.

3. Symbols and terms - alternatives

Power	W or P
Voltage	V or E or U
Phase	Active

Question 1	*Marks*	*Reference*	*Marking notes*
(a) ● The unearthed conductive parts of the fittings are separated from live parts by no more than basic insulation.	(1 mark)	ESR 22 (a)	
● The fitting is intended to have, or is supplied as having, a safety function, but does not in fact serve that safety function.	(1 mark)	ESR 22 (b)	
(b) (i) Any ONE of:	(1 mark)		
● 0.5 s at its rated residual current.		ESR 24 (4)(a)(i)	
● 0.15 s at 5 times its rated residual current.		ESR 24 (4)(a)(ii)	
(ii) 300 mA.	(1 mark)	ESR 24 (4)(b)	
(c) Any ONE of:	(2 marks)		
● The alteration and does not impair the safety of the existing electrical installation.		AS/NZS 3000: 1.8	
● Shall not cause any portion of the original electrical installation to carry current or sustain voltages in excess of those permitted by this Standard.		AS/NZS 3000: 1.9.3(a)	
● Shall not cause any portion of the original electrical installation to be used in any manner that is not in accordance with this Standard.		AS/NZS 3000: 1.9.3(b)	
● The alteration and does not impair the safety of the existing electrical installation.		AS/NZS 3000: 8.1.2	

Question 1	*Marks*	*Reference*	*Marking notes*
(d) Any TWO of: ● The electrical equipment operates under conditions of fluctuating or intermittent loading, or a definite duty cycle. ● The electrical installation is large and complex. ● Special types of occupancy exist.	(2 marks)	AS/NZS 3000 2.2.2(b)(i) AS/NZS 3000 2.2.2(b)(ii) AS/NZS 3000 2.2.2(b)(iii)	
(e) (i) Orange marker tape.	(1 mark)	AS/NZS 3000: 3.11.4.5	
(ii) Any ONE of: * Permanent cable marker signs shall be provided to indicate the point where cable enters or leaves a structure. * Recorded on a plan, and the plan located at the switchboard from where the cable originates.	(1 mark)	AS/NZS 3000: 3.11.4.6(a) AS/NZS 3000: 3.11.4.6(b)	
(f) Any TWO of: ● The capacitor shall be connected so that the windings of the appliance form a permanent discharge path for the capacitor. ● No switch or fuse shall be inserted between the capacitor and appliance. ● The capacitor shall be deemed to be controlled by the control gear of the appliance.	(2 marks)	AS/NZS 3000 4.15.3.2 (a) AS/NZS 3000 4.15.3.2 (b) AS/NZS 3000 4.15.3.2 (c)	

Question 1	*Marks*	*Reference*	*Marking notes*
(g) Any TWO of: ● Be accessible for visual inspection and for the purposes of testing. ● Be made by means of a suitable device in accordance with the manufacturer's instructions that provides adequate electrical conductivity. ● Provide protection against mechanical damage likely to occur to the main earthing conductor or the connection to the electrode at the location in accordance with clause 5.5.2.2. ● Be suitably protected against corrosion in accordance with clause 5.5.5.3.	(2 marks)	AS/NZS 3000 5.5.1.2 (a) AS/NZS 3000 5.5.1.2 (b) AS/NZS 3000 5.5.1.2 (c) AS/NZS 3000 5.5.1.2 (d)	
(h) ● Where the socket outlet is installed in Zone 2.	(1 mark)	AS/NZS 3000 6.2.4.2(b)(ii)	
● Where the socket outlet is installed in Zone 3.	(1 mark)	AS/NZS 3000 6.2.4.2(c)(i)	
(i) ● The protective device shall comply with the appropriate requirements of clause 2.2 and 2.5.	(1 mark)	AS/NZS 3000 7.5.9.1(a)	
● The protective devices shall be installed in all unearthed conductors.	(1 mark)	AS/NZS 3000 7.5.9.1(b)	

Question 1	*Marks*	*Reference*	*Marking notes*
(j) Any ONE of:	(2 marks)		
● Hazardous area (gas or vapour) in which an explosive gas atmosphere is present, or may expected to be present, in quantities such as to require special precautions for the construction installation and use of apparatus.		AS/NZS 3000 7.7.2.2(a)	
● Hazardous area (dust) in which combustible dust is present, or may expected to be present, in quantities such as to require special precautions for the construction installation and use of equipment.		AS/NZS 3000 7.7.2.2(b)	
● Heavier-than-air bottled gas cylinders with an aggregate gas capacity exceeding 30 m^3.		AS/NZS 3000 2.9.2.5(k) Note 1(a)	
● Gas-tank filling or discharge connections.		AS/NZS 3000 2.9.2.5(k) Note 1(b)	
● Pressure relief device discharge points fitted to gas installations.		AS/NZS 3000 2.9.2.5(k) Note 1(c)	
● Area in which an explosive atmosphere is present, or may be expected to be present, in quantities such as to require special precautions for the construction, installation and use of equipment.		AS/NZS 3000 1.4.11	

Question 2	*Marks*	*Reference*	*Marking notes*
(a) Any TWO of:	(2 marks)		
● By provision of a system of equipotential bonding in which exposed conductive parts are connected to a protective earthing conductor.		AS/NZS 3000 1.5.5.3(a)(i)	
● By disconnection of a fault by a protective device.		AS/NZS 3000 1.5.5.3(a)(ii)	
● Provision of a system of earthing in which exposed conductive parts are connected to a protective earthing conductor in accordance with section 5.		AS/NZS 3000 2.4.2(a)	
● Disconnection of a fault by an overcurrent protective device or an RCD		AS/NZS 3000 2.4.2(a)	
● By the provision of a protective earthing system in which exposed conductive parts are connected via conductors or similar medium to the earthed neutral of the distribution system.		AS/NZS 3000 5.2.1(a)	
● In the event of a fault or excessive earth leakage current flowing in the protective earthing system, overcurrent or earth leakage current protective devices operate to disconnect the affected part of the installation within the specified time and touch voltage limits.		AS/NZS 3000 5.2.1(b)	
(b) Any ONE of:	(2 marks)		
● If a fault of negligible impedance occurs anywhere in the electrical installation between an active conductor and a protective earthing conductor of exposed conductive part, automatic disconnection of supply will occur with the specified time.		AS/NZS 3000 1.5.5.3(c) 5.7.4	
● The impedance of the earthing system shall be limited to that which will generate sufficient current in the protective device to cause operation of that device within the required time.		AS/NZS 3000 5.7.1	
● In the event of such a fault the circuit protective device must interrupt the resulting fault current		AS/NZS 3000 B4.2	

Question 2	*Marks*	*Reference*	*Marking notes*
sufficiently quickly to prevent the touch voltage persisting long enough to be dangerous.			
● This method of protection relies on the combination of two conditions:			
* The provision of a conducting path, designated the “earth fault-loop” to provide for the circulation of the fault current		AS/NZS 3000 B4.2(a)	
* The interruption of the fault current within the maximum time by an appropriate protective device.		AS/NZS 3000 B4.2(b)	
● By the provision of a protective earthing system in which exposed conductive parts are connected via conductors or similar medium to the earthed neutral of the distribution system.		AS/NZS 3000 5.2.1(a)	
● In the event of a fault or excessive earth leakage current flowing in the protective earthing system, overcurrent or earth leakage current protective devices operate to disconnect the affected part of the installation within the specified time and touch voltage limits.		AS/NZS 3000 5.2.1(b)	
(c) Any ONE of:			
● The protective earthing conductor including the main earthing terminal/connection or bar and MEN.	(1½ marks)	AS/NZS 3000: B4.4(a)	A pictorial description of the loop in an acceptable alternative.
The neutral return path consisting of the neutral conductor between the main neutral terminal or bar and the neutral point at the transformer.	(1½ marks)	AS/NZS 3000: B4.4(b)	
The path through the neutral point of the transformer and the transformer winding.	(1½ marks)	AS/NZS 3000: B4.4(c)	
The active conductor as far as the active terminal of the socket outlet.	(1½ marks)	AS/NZS 3000: B4.4(d)	
● The active conductor as far as the point of the fault, including supply lines, service line, consumers mains, submains (if any) and the final subcircuit.	(1½ marks)	AS/NZS 3000: 5.7.3(a)	
The protective earthing conductor	(1½ marks)	AS/NZS 3000:	

Question 2	*Marks*	*Reference*	*Marking notes*
(PE), including the main earthing terminal/connection or bar and MEN connection.		5.7.3(b)	
The neutral-return path, consisting of the neutral conductor (N) between the main neutral terminal or bar and the neutral point at the transformer, including supply mains, service line and consumers mains.	(1½ marks)	AS/NZS 3000: 5.7.3(c)	
The path through the neutral point of the transformer and the transformer winding.	(1½ marks)	AS/NZS 3000: 5.7.3(d)	

Question 3	*Marks*	*Reference*	*Marking notes*
(a) (i) ● Zone 0 correctly drawn	(½ mark)	AS/NZS 3000 Figure 6.9	If Zone 0 is not drawn, 1 mark for Zone 1 Zone dimensions can be obtained from figure 6.3
● Zone 1 correctly drawn	(½ mark)	AS/NZS 3000 Figure 6.9	
● Zone 2 correctly drawn	(½ mark)	AS/NZS 3000 Figure 6.9	
● Zone 3 correctly drawn	(½ mark)	AS/NZS 3000 Figure 6.9	
(ii) ● Zone 0 correctly drawn	(½ mark)	AS/NZS 3000 Figure 6.10	
● Zone 2 correctly drawn	(½ mark)	AS/NZS 3000 Figure 6.10	
(b) (i) Zone 1	(½ mark)	AS/NZS 3000 Figure 6.4	
(ii) IPX5	(½ mark)	AS/NZS 3000 6.2.4.1 (b)	
(c) (i) Zone 3	(½ mark)	AS/NZS 3000 Figure 6.9	
(ii) IPX5	(½ mark)	AS/NZS 3000 6.2.4.1 (b)	
(d) Any ONE of:			
● (i) Installed on the west wall outside the bathroom	(½ mark)	AS/NZS 3000 Figure 6.9	
(ii) No degree of protection required	(½ mark)		
● (i) Installed on the west wall inside the bathroom		AS/NZS 3000 Figure 6.9	
(ii) IPX5		AS/NZS 3000 6.2.4.1 (b)	

Question 3	*Marks*	*Reference*	*Marking notes*
(e) (i) Zone 3	(½ mark)	AS/NZS 3000 Figure 6.9	
(ii) IPX5	(½ mark)	AS/NZS 3000 6.2.4.1 (b)	
(f) (i) Zone 3	(½ mark)	AS/NZS 3000 Figure 6.9	
(ii) IPX5	(½ mark)	AS/NZS 3000 6.2.4.1 (b)	
(iii) • Protected by a RCD with a fixed rated residual current not exceeding 30 mA.	(1 mark)	AS/NZS 3000 6.2.4.2 (c)(i)	
• Supplied individually as a separated circuit in accordance with clause 7.4.	(1 mark)	AS/NZS 3000 6.2.4.2 (c)(ii)	

Question 4			*Marks*	*Reference*	*Marking notes*
(a)	(i)	To ensure that the earthing system has been installed in a manner that will cause the circuit protective devices to operate if there is a fault between live parts, other than the neutral and the mass of earth.	(2 marks)	AS/NZS 3000 8.3.5.1	
	(ii)	- Shall be low enough to permit the passage of current necessary to operate the overcurrent protective device.	(1 mark)	AS/NZS 3000 8.3.5.2(a)	
		- Shall be consistent with the length, cross-sectional area and type of conductor material.	(1 mark)	AS/NZS 3000 8.3.5.2(b)	
(b)	(i)	1.53 Ω	(½ mark)	AS/NZS 3000 Table 8.1	
	(ii)	0.49 Ω	(½ mark)	AS/NZS 3000 Table 8.2	
	(iii)	0.49 Ω	(½ mark)	AS/NZS 3000 Table 8.2	
	(iv)	68 metres	(½ mark)	AS/NZS 3000 Table B1	
(c)	(i)	1.64 Ω	(½ mark)	AS/NZS 3000 Table 8.1	
	(ii)	0.43 Ω	(½ mark)	AS/NZS 3000 Table 8.2	
	(iii)	0.18 Ω	(½ mark)	AS/NZS 3000 Table 8.2	
	(iv)	60 metres	(½ mark)	AS/NZS 3000 Table B1	

Question 4	*Marks*	*Reference*	*Marking notes*
(d) Any TWO of: - There is no short-circuit between conductors. - There is no transposition of conductors that could result in the earthing system and any exposed conductive parts of the electrical installation becoming energised. - There is no interconnection of conductors between different circuits.	(2 marks)	AS/NZS 3000 8.3.8.2(a) AS/NZS 3000 8.3.8.2(b) AS/NZS 3000 8.3.8.2(c)	

Question 5	*Marks*	*Reference*	*Marking notes*
(a) (i) A MEN Link.	(½ mark)	GK	
(ii) ● The active conductor to the line side of the main switch.	(½ mark)	GK	
● The neutral conductor to the main neutral bar.	(½ mark)	GK	
(iii) To the earth bar.	(½ mark)	GK	
(b) (i) ● The 2.5 mm^2 twin and earth TPS cable supplying a permanently-connected hair-dryer in a bathroom.	(1 mark)		
● The 5,1.5 mm^2 twin and earth TPS cables supplying lights.	(½ mark)		
● The 14, 2.5 mm^2 twin and earth TPS cables supplying socket outlets.	(½ mark)		
(ii) ● One 10A RCBO has the active conductors of 3, 1.5 mm^2 light final subcircuit cables.	(1 mark)	AS/NZS 3000 2.6.2.4(a)	
● One 10A RCBO has the active conductors of 2. 1.5 mm^2 light final subcircuit cables.	(1 mark)	AS/NZS 3000 2.6.2.4(a)	
● One 20A RCBO has the active conductors of 3, 2.5 mm^2 socket outlet final subcircuit cables.	(½ mark)	AS/NZS 3000 2.6.2.4(b)	
● One 20A RCBO has the active conductors of 3, 2.5 mm^2 socket outlet final subcircuit cables.	(½ mark)	AS/NZS 3000 2.6.2.4(b)	
● One 20A RCBO has the active conductors of 3, 2.5 mm^2 socket outlet final subcircuit cables.	(½ mark)	AS/NZS 3000 2.6.2.4(b)	
● One 20A RCBO has the active conductors of 3, 2.5 mm^2 socket outlet final subcircuit cables.	(½ mark)	AS/NZS 3000 2.6.2.4(b)	
● One 20A RCBO has the active conductors of 2, 2.5 mm^2 socket outlet final subcircuit cables and the 2.5 mm^2 final	(1 mark)	AS/NZS 3000 2.6.2.4(b) 2.6.3.1(c)	

Question 5	*Marks*	*Reference*	*Marking notes*
subcircuit cable supplying the hair dryer permanent connection units.			
(iii) They are supplied from the load side of the main switch.	(½ mark)	GK	
(iv) They are supplied from the neutral bar.	(½ mark)	GK	

Solution 1 – Using load group B(i) for the 10A socket outlets

Equipment	Load Group	Calculation	Load A	Marks
17 45W fluorescent lights	A	(17 x 45) ÷ 230 = 3.33	3.33	(1 mark)
4 60W outside lights	A	(4 x 60) ÷ 230 = 1	1	(1 mark)
10 10A single socket outlets	B(i)	(1000 + (9 x 750)) ÷ 230 =33.7	33.7	(1½ marks)
2 15A single socket outlets	B(iii)	15 + (1 x 15 x 0.75) = 26.25	26.25	(1 mark)
2. 1.5 kW automatic hand-dryers	C	(2 x 1500 x 0.75) ÷ 230 = 9.78	9.78	(1½ marks)
2 2 kW instantaneous water heaters	C	(2 x 2000 x 0.75) ÷ 230 = 13.04	13.04	(1½ marks)
1 6 kW input air conditioner	C	6000 ÷ 230 = 26.1	26.1	(1½ marks)
Total			113.2	(1 mark)

Accept a total in the range 110A to 115A

AS/NZS 3000: Table C2, Column 3

Solution 2 – Using load group B(ii) for the 10A socket outlets

Equipment	Load Group	Calculation	Load A	Marks
17 45W fluorescent lights	A	(17 x 45) ÷ 230 = 3.33	3.33	(1 mark)
4 60W outside lights	A	(4 x 60) ÷ 230 = 1	1	(1 mark)
10 10A single socket outlets	B(ii)	(1000 + (9 x 100)) ÷ 230 =8.26	8.26	(1½ marks)
2 15A single socket outlets	B(iii)	15 + (1 x 15 x 0.75) = 26.25	26.25	(1 mark)
2. 1.5 kW automatic hand-dryers	C	(2 x 1500 x 0.75) ÷ 230 = 9.78	9.78	(1½ marks)
2 2 kW instantaneous water heaters	C	(2 x 2000 x 0.75) ÷ 230 = 13.04	13.04	(1½ marks)
1 6 kW input air conditioner	C	6000 ÷ 230 = 26.1	26.1	(1½ marks)
Total			87.76	(1 mark)

Accept a total in the range 83A to 90A

AS/NZS 3000: Table C2, Column 3

Question 7	*Marks*	*Reference*	*Marking notes*
(a) (i) Any TWO of:	(2 marks)		
● Located so the switchboard and access to it is not obstructed by the structure or contents of the building or by fittings or fixtures within the building.		AS/NZS 3000: 2.9.2.2(a)	
● Be provided with adequate space around the switchboards on all sides where persons are to pass to enable all electrical equipment to be safely and effectively operated and adjusted.		AS/NZS 3000: 2.9.2.2(b)	
● There must be an unimpeded space of at least 0.6m around the switchboard.		AS/NZS 3000: 2.9.2.2(i)	
● With the switchboard doors in any position.		AS/NZS 3000: 2.9.2.2(i)	
(ii) Any TWO of:	(2 marks)		
● Located so the switchboard and access to it is not obstructed by the structure or contents of the building or by fittings or fixtures within the building.		AS/NZS 3000: 2.9.2.2(a)	
● Be provided with sufficient exit facilities to enable a person to leave the vicinity of the switchboard under emergency conditions.		AS/NZS 3000: 2.9.2.2(c)	
● Shall open in the direction of egress without the use, on the switchboard side of the door, of a key or tool.	(1 mark)	AS/NZS 3000: 2.9.2.2	
● Door that open into a passage shall be capable of being secured in the open position to prevent workers being inadvertently being pushed towards the switchboard.	(1 mark)	AS/NZS 3000: 2.9.2.2	
● Openings or doorways that are at least 0.75 m wide by 1.98 m high to allow persons necessary access to the switchboard room or enclosure.	(1 mark)	AS/NZS 3000: 2.9.2.2(iii)	

Question 7	*Marks*	*Reference*	*Marking notes*
(b) • Designed so that the incoming neutral conductor cannot be inadvertently disconnected from the bar or link. • Provided with a separate terminal for the incoming neutral conductor terminating at the switchboard.	(1 mark) (1 mark)	AS/NZS 3000: 2.9.4.3(b) AS/NZS 3000: 2.9.4.3(d)(i)	
(c) Any FOUR of: • It shall effectively isolate all active supply conductors from the circuit. • Shall be capable of withstanding an impulse voltage at the point of installation, or shall have an appropriate contact gap. • Not be able to falsely indicate that the contacts are open. • Shall clearly and reliably indicate the isolating position of the device. • Be designed and installed so as to prevent unintentional closure. • Be a device that disconnects all active conductors of the relevant supply. • Be readily available. • Where the device is a switching device, it shall be capable of being secured in open position.	(2 marks)	AS/NZS 3000 2.3.2.2.1 AS/NZS 3000 2.3.2.2.1(a) AS/NZS 3000 2.3.2.2.1(b) AS/NZS 3000 2.3.2.2.1(c) AS/NZS 3000 2.3.2.2.1(d) AS/NZS 3000 2.3.2.2.1(e) AS/NZS 3000 2.3.2.2.1(f) AS/NZS 3000 2.3.2.2.1	
(d) Any ONE of: • To prevent the submain protective earthing conductor from carrying load current. • The link is in the MEN switchboard • To prevent RF interference to telecommunication and electronic equipment connected to the installation.	(2 marks)	GK	

Question 8	*Marks*	*Reference*	*Marking notes*
(a) (i) ● The socket outlet final subcircuits in the new rooms.	(1 mark)	AS/NZS 3000: 2.6.3.1(a)	
● The lighting final subcircuits in the new rooms.	(1 mark)	AS/NZS 3000: 2.6.3.1(b)	
(ii) ● 2 RCCBs	(½ mark)	AS/NZS 3000: 2.6.2.4(a)	
● 2 MCBs	(½ mark)	AS/NZS 3000: 2.6.2.4(a)	
(iii) Any ONE of: ● 3 RCCBs 3 MCBs ● 2 RCCBs 3 MCBs ● 2 RCCBs 2 MCBs	(1 mark)	AS/NZS 3000: 2.6.2.4(b)	
(iv) 2 RCBOs	(½ mark)	AS/NZS 3000: 2.6.2.4(a)	
(v) Any ONE of: ● 2 RCBOs ● 3 RCBOs	(½ mark)	AS/NZS 3000: 2.6.2.4(b)	
(b) (i) ● The new socket outlet final subcircuits.	(½ mark)	AS/NZS 3000: 2.6.3.4	
● The existing socket outlet final subcircuits.	(½ mark)	AS/NZS 3000: 2.6.3.4	
● The existing lighting final subcircuits.	(½ mark)	AS/NZS 3000: 2.6.3.4	
(ii) ● The range socket outlet is located in a position that is not likely to be accessed for general purposes.	(1 mark)	AS/NZS 3000: 2.6.3.1 Exception 3(a)	
● The range socket outlet is clearly marked to indicate the restricted purpose of the socket outlet and that RCD protection is not provided.	(1 mark)	AS/NZS 3000: 2.6.3.1 Exception 3(b)	

Question 8	*Marks*	*Reference*	*Marking notes*
● The instantaneous water heater final subcircuit. The water heater is not hand-held electrical equipment.	(1½ marks)	AS/NZS 3000: 2.6.3.1(c)	

Question 9		*Marks*	*Reference*	*Marking notes*
(a)	• At the source of supply.	(1 mark)	AS/NZS 3000: 5.1.3	
	• At regular intervals throughout the system.	(1 mark)	AS/NZS 3000: 5.1.3	
	• At each electrical installation connected to the system.	(1 mark)	AS/NZS 3000: 5.1.3	
(b)	The requirement for protective purposes shall prevail.	(1 mark)	AS/NZS 3000: 5.2.3 5.3.7	
(c)	Any ONE of:	(2 marks)		
	• Materials other than copper or aluminium may be used as an earthing conductor. In such cases the conductor resistance shall not be greater than that for a copper earthing conductor determined in accordance with clause 5.3.3. and the degree of corrosion resistance shall not be inferior to other materials suitable for the purpose.		AS/NZS 3000: 5.3.2.1.3	
	• The electrical equipment to be earthed is supplied by the conductors contained within the wiring enclosure.		AS/NZS 3000: 5.3.2.3(a)(i)	
	• The wiring enclosure is directly connected by conductive threads or locknuts to the electrical equipment to be earthed.		AS/NZS 3000: 5.3.2.3(a)(ii)	
(d)	Any ONE of:	(2 marks)		
	• The connection of exposed conductive parts shall be made automatically, before the live connections are made, when any plug portion is inserted in the corresponding socket outlet.		AS/NZS 3000: 5.5.4.4(a)	
	• The connection of exposed conductive parts shall be broken automatically, not before the live connections are broken, when any plug portion is withdrawn from the corresponding socket outlet.		AS/NZS 3000: 5.5.4.4(b)	

Question 9	*Marks*	*Reference*	*Marking notes*
(e) • Shall not be used to fix the electrical equipment in position.	(1 mark)	AS/NZS 3000: 5.5.6.2(d)(i)	
• Shall not be used to adjust the position of the electrical equipment or any part of it.	(1 mark)	AS/NZS 3000: 5.5.6.2(d)(ii)	